WE CLAIM:

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1. In an atomic force microscope including at least one cantilever mounted therein and an optical detector, the improvement, for generating a small incident beam spot, comprising:

an optical system including a light source and means for producing a focused incident beam; and

means for directing said focused incident beam onto said cantilever to reflect therefrom to said detector;

said optical system having a numerical aperture sufficient with the wavelength of light from said light source whereby said focused beam forms a spot on said cantilever having a size of 8 μm or less in at least one dimension.

2. The atomic force microscope of Claim 1 in which said cantilever has a length of less than 30 μm.

3. The atomic force microscope of Claim 1 including means for defining an aperture in the path of said incident beam and means for adjusting the size of said aperture whereby to control the size of said incident beam spot on said cantilever.

4. The atomic force microscope of Claim 1 including means for defining an aperture in the path of said incident beam and means for adjusting the shape of said aperture whereby to control the shape of said incident beam spot on said cantilever.

2 ~~5.~~ The atomic force microscope of Claim 1 in which the components of said optical system are arranged so that at least portions of said incident and reflected beams overlap, and including means for separating said reflected beam from said incident beam and directing said separated reflected beam to said detector.

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3 ~~6~~. The atomic force microscope of Claim 2 ~~5~~ in which said separating means comprises a polarizing beamsplitter in the path of said incident and reflected beams arranged to pass light having a first polarization direction and to reflect light having a second polarization direction, and including means located between said beamsplitter and said cantilever, in the path of said overlapping beams, for converting at least a portion of said reflected light beam into said second polarization direction.

4 ~~7~~. The atomic force microscope of claim 3 ~~6~~ in which said converting means comprises a quarterwave plate that elliptically polarizes the incident beam and linearly polarizes the reflected beam.

5 ~~8~~. The atomic force microscope of Claim 2 ~~5~~ including a polarizer in the path of said incident beam but outside the path of said overlapping beams arranged to pass light having substantially only a first polarization direction, said separating means comprising a beamsplitter in the path of said incident and reflected beams arranged to pass light having said first polarization direction and to reflect light having a second polarization direction and means located between said beamsplitter and said cantilever, in the path of said overlapping beams, for converting at least a portion of said reflected light beam into said second polarization direction.

6 ~~9~~. The atomic force microscope of Claim 5 ~~8~~ in which said converting means comprises a quarterwave plate that elliptically polarizes the incident beam and linearly polarizes the reflected beam.

10. The atomic force microscope of Claim 1 in which said means for directing said incident beam onto said cantilever comprises a lens disposed to focus said incident beam to a spot on said cantilever, and including means confocal with said lens for viewing the location of said spot.

18 ~~11~~. The atomic force microscope of Claim 17 ~~10~~ in which at least portions of said incident and reflected beams and said viewing means

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share a common optical path.

~~12.~~ 19. The atomic force microscope of Claim ~~11~~ 18 in which said light source is a source of collimated light and the optics of said viewing means is infinity-corrected.

~~13.~~ 20. The atomic force microscope of Claim ~~11~~ 18 in which said viewing means includes a translatable lens in said common optical path whereby translation thereof to focus the image of the cantilever in the viewing means results in focusing the incident beam in the plane of the cantilever.

~~14.~~ 7. The atomic force microscope of Claim 1 including means for disposing the plane of the focus of the incident beam coincident with the plane of said cantilever.

~~15.~~ 8. The atomic force microscope of Claim ~~14~~ 7 in which said focus plane disposing means comprises at least one focusing lens disposed to focus said incident beam onto said cantilever and means for tilting said focusing lens until the plane of focus thereof is coincident with the plane of the cantilever.

~~16.~~ 9. The atomic force microscope of Claim ~~14~~ 7 in which said focus plane disposing means comprises at least one focusing lens disposed to focus said incident beam onto said cantilever, the optical axis thereof being disposed to be perpendicular to the plane of said cantilever.

~~17.~~ 10. The atomic force microscope of Claim 1 having a plurality of cantilevers and including means for shifting the focus spot of said incident beam from one cantilever to another and means for disposing the plane of the focus of the incident beam coincident with the plane of at least one of said plurality of cantilevers whereby said incident beam will be

substantially in focus with the cantilever to which the focus spot has been shifted.

~~18~~ 11. The atomic force microscope of Claim 1 having removably mounted therein a module to which said cantilever is mounted, and including a focusing lens mounted on said module and focusing said incident beam to a spot on said cantilever.

~~19~~ 12. The atomic force microscope of Claim 1 including at least one tapping piezoelectric element, said module being supported thereon to facilitate tapping mode operation.

~~20~~ 13. The atomic force microscope of Claim ~~19~~ 12 in which said module is disposed on a support, said tapping piezoelectric element being embedded in said support.

~~21~~ 14. The atomic force microscope of Claim 1 in which the wavelength of light from said light source is 670 nm and said numerical aperture is greater than 0.05.

~~22~~ 21. In an atomic force microscope including at least one cantilever mounted therein and an optical detector, the improvement, for generating a small incident beam spot, comprising:

an optical system, including:

a collimated light source for producing an incident beam,

means for defining an aperture in the path of said incident beam,

means for adjusting the size of said aperture whereby to control the size of at least one dimension of said incident beam,

a focusing lens disposed to focus said incident beam to

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produce a focused incident beam,

means for directing said focused incident beam onto said cantilever to reflect therefrom to said detector, at least portions of said incident and reflected beams overlapping,

said optical system having a numerical aperture sufficient with the wavelength of light from said light source whereby said focused beam forms a spot on said cantilever having a size of 8 μm or less in at least said one dimension,

means for separating said reflected beam from said incident beam whereby to direct said separated reflected beam to said detector, comprising a polarizing beamsplitter in the path of said incident and reflected beams arranged to pass light having a first polarization direction and to reflect light having a second polarization direction, and

a quarterwave plate located between said beamsplitter and said cantilever in the path of said overlapping beams, for elliptically polarizing said incident beam and linearly polarizing said reflected beam, whereby to impart said second polarization direction to said reflected beam;

viewing means confocal with said focusing lens and sharing a common path with said overlapping incident and reflected beams for viewing the location of said spot on said cantilever;

a translatable lens in said common optical path for focusing the image of the cantilever in said viewing means, the optical axis of said translatable lens and focusing lens being disposed to be perpendicular to the plane of said cantilever whereby to focus the incident beam in the plane of said cantilever;

a removably mounted module to which said cantilever is mounted, said focusing lens being mounted on said module; and

at least one tapping mode piezoelectric element, said module being supported thereon.

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22 ~~23.~~ The atomic force microscope of Claim ~~22~~ 21 in which the wavelength of light from said light source is 670 nm and said numerical aperture is greater than 0.05.

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